Near Infrared Light Triggered Nitric Oxide-Enhanced Photodynamic Therapy and Low-Temperature Photothermal Therapy for Biofilm Elimination.

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Abstract

Photothermal treatment (PTT) involving combination therapeutic modalities were recently emerged as an efficient alternative for combating biofilm. However, PTT-related local high temperature may destroy the surrounding healthy tissues. Herein, we present an all-in-one photo-therapeutic nanoplatform consisting of L-arginine (L-Arg), indocyanine green (ICG) and mesoporous polydopamine (MPDA), namely AI-MPDA, to eliminate the already-formed biofilm. The fabrication process included surface modification of MPDA with L-Arg and further adsorption of ICG via π-π stacking. Under near infrared (NIR) exposure, AI-MPDA not only generated heat, but also produced reactive oxygen species (ROS), causing cascade catalysis of L-Arg to release nitric oxide (NO). Under near infrared (NIR) irradiation, biofilm elimination was attributed to the NO-enhanced photodynamic therapy (PDT) and low-temperature PTT (≤ 45 °C). Notably, NIR-triggered all-in-one strategy resulted in severe destruction of bacterial membranes. The photo-therapeutic AI-MPDA also displayed good cytocompatibility. NIR-irradiated AI-MPDA nanoparticles not only prevented bacterial colonization, but also realized a rapid recovery of infected wound. More importantly, the all-in-one photo-therapeutic platform displayed effective biofilm elimination with an efficiency of around 100% in a abscess formation model. Overall, this low-temperature photo-therapeutic platform provides a reliable tool for combating already-formed biofilm in clinical applications.